U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: CONTINUING STRUCTURAL INTEGRITY PROGRAM FOR AIRPLANES

Date: 3/7/2008
Initiated by: ANM-115

AC No: 91-56B

1. PURPOSE. This advisory circular (AC) provides guidance material to design approval holders and operators for use in developing a damage tolerance based supplemental structural inspection program (SSIP) for older airplanes. This AC also references and briefly describes other elements of a continuing structural integrity program that support the safe operation of transport category airplanes throughout their operational lives.

2. APPLICABILITY.

a. This AC applies to design approval holders and operators of transport category airplanes. This AC may also be used by design approval holders and operators of normal, acrobatic, utility and commuter category airplanes. This guidance may be useful for design approval holders that choose to certificate a small airplane according to the damage tolerance requirements of Title 14, Code of Federal Regulations (CFR) part 23. This guidance may be useful for small airplane design approval holders and operators that choose to develop a structural integrity program as a non-mandatory operational safeguard against the effects of structural aging.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for showing compliance with the applicable regulations. The Federal Aviation Administration (FAA) will consider other methods of demonstrating compliance that an applicant may elect to present. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. On the other hand, if we become aware of circumstances that convince us that following this AC would not result in compliance with the applicable regulations, we will not be bound by the terms of this AC, and we may require additional substantiation or design changes as a basis for finding compliance.

c. This material does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

3. CANCELLATION. This AC cancels AC 91-56A, *Continuing Structural Integrity Program for Large Transport Category Airplanes*, dated April 29, 1998.

4. RELATED REGULATIONS AND DOCUMENTS.

a. Title 14, Code of Federal Regulations (14 CFR). You may get a copy of 14 CFR, parts 23, 25, 43, 91, 121, and 129 on-line at http://www.gpoaccess.gov/cfr. You may order a paper copy from the U.S. Superintendent of Documents, U.S. Government Printing Office, Washington D.C., 20402-001; or by calling telephone number (202) 512-1800; or by facsimile (202) 512-2250.

(1) Part 23, §§ 23.571, 23.572, 23.573, 23.574, Small airplane requirements for fatigue, fail-safe, and damage-tolerance evaluations.

(2) Part 25, § 25.571, Damage-tolerance and fatigue evaluation.

(3) Part 43, § 43.16, Airworthiness Limitations.

(4) Part 91, § 91.403, General.

(5) Part 121, § 121.1109, Supplemental inspections.

(6) Part 129, § 129.109, Supplemental inspections for U.S.-registered aircraft.

b. Advisory Circulars: You may download an electronic copy of the latest version of the following ACs from the Internet at http://rgl.faa.gov.

(1) AC 25.571-1C, *Damage Tolerance and Fatigue Evaluation of Structure*, dated April 29, 1998.

(2) AC 120-73, *Damage Tolerance Assessment of Repairs to Pressurized Fuselages*, dated December 14, 2000.

(3) AC 120-93, *Damage Tolerance Inspections for Repairs*, dated November 20, 2007.

5. BACKGROUND.

a. Service experience has demonstrated that there is a need to have continuing updated knowledge concerning the structural integrity of airplanes, especially as they became older. The structural integrity of these airplanes is of concern, since such factors as fatigue cracking and corrosion are time dependent and knowledge concerning them can best be assessed on the basis of real time operational experience and the use of the most modern tools of analysis and testing.

b. The FAA, manufacturers, and operators have continually worked to maintain the structural integrity of older airplanes. Traditionally, this has been accomplished through an exchange of field service information and subsequent changes to inspection programs, and by the development and installation of modifications on particular aircraft. However, increased utilization, longer operational lives, and the high safety demands imposed on airplanes indicate the need for a program to ensure a high level of structural integrity. Accordingly, the inspection and evaluation programs outlined in this AC are intended to ensure a continuing structural integrity assessment by each airplane manufacturer and the incorporation of the results of each assessment into the maintenance program of each operator.

c. The previous version of this AC (AC 91-56A) provided guidance to support the development of a damage tolerance based supplemental structural inspection program (SSIP) for large transport airplanes certified under the fail-safe and fatigue requirements of Civil Air Regulations (CAR) 4b or part 25, prior to Amendment 25-45. That guidance was traditionally applied to the following eleven large transport airplane models: Airbus Model A300; British Aerospace Model BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Model DC-8, DC-9/MD-80, DC-10; Fokker Model F28; and Lockheed Model L-1011 series airplanes. For each of these models, airworthiness directives (ADs) were issued to mandate the implementation of damage-tolerance based SSIPs. These airplanes have a maximum takeoff gross weight greater than 75,000 pounds.

d. In addition to these eleven airplane models, the guidance in the previous version of this AC (which is included in this revision) has been successfully used to develop a SSIP for airplanes with a maximum takeoff gross weight less than 75,000 pounds. As this guidance was determined to be applicable to smaller airplane models, the term "Large Transport Category" was removed from the title of this revision to the AC.

e. The Aging Airplane Safety Final Rule (AASFR) (70 FR 5518, February 2, 2005) expanded the requirement for damage tolerance based SSIPs beyond the eleven models mentioned above. The AASFR is applicable to all U.S.-registered transport category, turbine-powered airplanes, operated under Subpart D of part 121 and part 129, having a type certificate issued after January 1, 1958, that as a result of original type certification or later increase in capacity, have:

(1) a maximum type certificated passenger seating capacity of 30 or more; or

(2) a maximum payload capacity of 7,500 pounds or more.

f. An FAA-approved SSIP developed using the guidance in this AC is an acceptable means of compliance with the AASFR for those areas addressed by the SSIP. SSIPs typically apply to the baseline structure, which is defined as that originally designed by the original equipment manufacturer (OEM).

g. (1) In addition to SSIPs, this AC discusses the following additional elements of a continuing structural integrity program:

- Repairs, Alterations, and Modifications
- Mandatory Modification Program
- Corrosion Prevention and Control Program (CPCP)
- Repair Assessment Program

(2) Additional background information can be found in Appendix 4 of AC 120-93, *Damage Tolerance Inspections for Repairs and Alterations.*

6. SUPPLEMENTAL STRUCTURAL INSPECTION PROGRAMS. The manufacturer, in conjunction with operators, is expected to initiate development of a SSIP for each airplane model. Such a program should be implemented before analyses, tests, and/or service experiences indicate that a significant increase in inspection and/or modification is necessary to maintain structural integrity of the airplane. In the absence of other data as a guideline, the program should be initiated no later than the time when the high-time or high-cycle airplane in the fleet reaches one half its design service goal. This should ensure that an acceptable program is available to the operators when needed. The program should include procedures for obtaining service information, and assessment of service information, available test data, and new analysis and test data. The operator should develop a supplemental structural inspection document (SSID) from this body of data, as outlined in the appendix to this AC.

a. The recommended SSIP, along with the criteria used and the basis for the criteria, should be submitted to the cognizant FAA Aircraft Certification Office for review and approval. The supplemental program should be adequately defined in the SSID and presented in a manner that is effective. The SSID should include the type of damage being considered, and likely sites; inspection access, threshold, interval, method and procedures; applicable modification status and/or life limitation; and types of operations for which the SSID is valid.

b. The FAA review of the SSID will include both engineering and maintenance aspects of the proposal. Since the SSID is applicable to all operators and addresses a safety concern for older airplanes, it will be made mandatory under the existing Airworthiness Directive (AD) system if the FAA deems that an unsafe condition exists. In addition, any service bulletin or other service information publications found to be essential for safety during the initial SSID assessment process should be implemented by AD action. Service bulletins or other service information publications revised or issued as a result of in service findings resulting from implementation of the SSID should be added to the SSID or implemented by separate AD action, as appropriate.

c. In the event an acceptable SSID cannot be obtained on a timely basis, the FAA may impose service life, operational, or inspection limitations to assure structural integrity.

d. The design approval holder should revise the SSID whenever additional information shows a need. The original SSID will normally be based on predictions or assumptions (from analyses, tests and/or service experience) of failure modes, time to detectable fatigue cracking, frequency of damage, typically detectable damage, and the damage growth period. Consequently, a relieving change in these factors sufficient to justify a revision would have to be substantiated by test data or additional service information. Any revision to SSID criteria and the basis for these revisions should be submitted to the FAA for review and approval of both engineering and maintenance aspects.

7. REPAIRS, ALTERATIONS, AND MODIFICATIONS.

a. The AASFR requires operators of affected airplanes to develop damage tolerance (DT) - based inspections for all fatigue critical baseline structure. The AASFR also requires that the DT-based inspections address the adverse effects that repairs, alterations, and modifications may have on the fatigue critical baseline structure. While this AC provides guidance on developing an SSIP for fatigue critical baseline structure, AC 120-93, *Damage Tolerance Inspections for Repairs*, provides guidance to type certificate holders and operators on addressing repairs, alterations, and modifications as required by the AASFR.

b. Certain ADs that mandated SSIPs on older airplanes have addressed repairs, alterations, and modifications that affect principal structural elements. In addition, the *Repair Assessment for Pressurized Fuselages* rule (65 FR 24108, April 25, 2000) addresses repairs to the fuselage pressure boundary. The same data used for compliance with the SSIP ADs or the *Repair Assessment for Pressurized Fuselages* rule can be used to comply with the AASFR for the repairs, alterations, and modifications to the structure addressed by those data.

8. MANDATORY MODIFICATION PROGRAM.

a. The mandatory modification program was based on the premise that to ensure the structural integrity of older airplanes, there should be less reliance on repetitive inspections when certain criteria exist. These criteria included:

- The likelihood that known structural cracking problems exist and are not just theoretical or predicted.
- The consequences of failing to correct the problem must be catastrophic. This means that the structural element involved must be a principle structural element or other primary structure.
- The cracks must be difficult to detect during regular maintenance.

- Other considerations are: the areas to inspect are difficult to access; nondestructive test methods are un-suitable; or human factors of inspection are so adverse that crack detection may not be sufficiently dependable to assure safety.

b. The structural modification programs were mandated on the original eleven models (Airbus Model A300; British Aerospace Model BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Model DC-8, DC-9/MD-80, DC-10; Fokker Model F28; and Lockheed Model L-1011 series airplanes) by ADs. Each of the type certificate holders reviewed its service bulletins with the FAA to determine which areas of structure needed terminating modifications to inspections. The revised service bulletins that included those terminating modifications were then grouped in a document and mandated. However, some service bulletins were individually mandated.

c. The AASFR requires that all modifications affecting fatigue critical baseline structure be assessed, including any new fatigue critical structure created by such a modification. Guidelines for addressing modifications are in AC 120-93, *Damage Tolerance Inspection for Repairs*.

9. CORROSION PREVENTION AND CONTROL PROGRAM. A corrosion prevention and control program (CPCP) is a systematic approach to controlling corrosion in the airplane's primary structure. A CPCP consists of a basic corrosion inspection task, task areas, defined corrosion levels, and compliance times. The objective of a CPCP is to limit the material loss due to corrosion to a level necessary to maintain airworthiness.

a. The CPCPs were mandated by ADs for certain large transport category airplanes (Airbus Model A300; British Aerospace Model BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Model DC-8, DC-9/MD-80, DC-10; Fokker Model F28; and Lockheed Model L-1011 series airplanes) and many other transport category airplanes. The type certificate holders for these airplanes developed the CPCP document that was mandated by AD. These corrosion programs supplemented each operator's maintenance program.

b. The corrosion programs were developed based on the premise that operators could adjust them when unacceptable corrosion levels were found. These maintenance program adjustments should preclude recurrence of unacceptable corrosion findings. Adjustments may include actions such as reduced repetitive task intervals, improved corrosion treatments, or multiple corrosion inhibitor applications.

c. The FAA has withdrawn notice of proposed rulemaking (NPRM) Notice No. 02-16 (67 FR 62142, October 3, 2002) Corrosion Prevention and Control Program. That NPRM was withdrawn because the FAA's safety objectives are currently being met. Before issuing the CPCP proposal, the FAA issued ADs to address corrosion concerns on various airplane models. Also, during the rulemaking process, airplane manufacturers came to better understand the effects of corrosion and voluntarily developed CPCPs for their new airplane models using the Manufacturing Steering Group (MSG)-3 process. If an unsafe condition is identified on any airplane model not covered by a CPCP because of the withdrawal of the NPRM, the FAA will issue an AD to address that safety issue.

10. REPAIR ASSESSMENT PROGRAM. The FAA tasked the aviation industry to develop a method for airlines to evaluate airplane repairs to determine whether they are acceptable permanent repairs incorporating damage tolerance. This program ensures that existing repairs do not deteriorate due to accidental, fatigue, or environmental damage beyond FAA-approved levels for the remaining usage life of the airplane.

a. On January 2, 1998, an NPRM, *Repair Assessment for Pressurized Fuselages* (63 FR 126; Notice No. 97-16), was published in the *Federal Register*. The proposed rule would restrict the operation of certain large transport category airplanes (Airbus Model A300; British Aerospace Model BAC 1-11; Boeing Models B-707/720, B-727, B-737, B-747; McDonnell Douglas Model DC-8, DC-9/MD-80, DC-10; Fokker Model F28; and Lockheed Model L-1011 series airplanes) operated under parts 91, 121, 125, and 129 beyond a specified compliance time, unless the operator of those airplanes had incorporated FAA-approved repair assessment guidelines applicable to the fuselage pressure boundary (fuselage skin, door skin, and bulkhead webs) in its operation specification(s) or approved inspection program, as applicable. This rulemaking ensures that a comprehensive damage tolerance repair assessment be completed for fuselage pressure boundary repairs.

b. The final rule was published in the *Federal Register* on April 25, 2000 (65 FR 24108; Amendment Nos. 91-264, 121-275, 125-33, and 129-28) and became effective May 25, 2000. As a result of this final rule, the new operating rules are part 91, § 91.410; part 121, § 121.370; part 125, § 125.248; and part 129, § 129.32. AC 120-73, *Damage Tolerance Assessment of Repairs to Pressurized Fuselages*, provides an acceptable means of compliance with the regulations that require incorporating FAA-approved repair assessment guidelines into an operator's FAA-approved maintenance or inspection program.

11. Widespread Fatigue Damage. The FAA plans to address widespread fatigue damage through the rulemaking process.

Signed by Ali Bahrami

Ali Bahrami
Manager, Transport Airplane Directorate
Aircraft Certification Service

APPENDIX 1

GUIDELINES FOR DEVELOPING A SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENT

1. GENERAL.

a. The airplanes subject to this appendix were not certified to a damage tolerance requirement. However, the structure to be evaluated, the type of damage considered (fatigue, corrosion, service, and production damage), and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage tolerance principles of Title 14 of the Code of Federal Regulations (14 CFR) part 25, § 25.571. An acceptable means of compliance can be found in the current version of AC 25.571-1, *Damage Tolerance and Fatigue Evaluation of Structure*.

b. It is essential to identify the structural parts and components that contribute significantly to carrying flight, ground, pressure, or control loads, and whose failure could affect the structural integrity necessary for the continued safe operation of the airplane. The damage tolerance or safe-life characteristics of these parts and components must be established or confirmed.

c. Analyses made with respect to the continuing assessment of structural integrity should be based on supporting evidence, including test and service data. This supporting evidence should include consideration of the operating loading spectra, structural loading distributions, and material behavior. An appropriate allowance should be made for the scatter in life to crack initiation and rate of crack propagation in establishing the inspection threshold, inspection frequency, and, where appropriate, retirement life. Alternatively, an inspection threshold may be based solely on a statistical assessment of fleet experience, provided that it can be shown that equal confidence can be placed in such an approach.

d. An effective method of evaluating the structural condition of older airplanes is selective inspection with intensive use of nondestructive techniques and the inspection of individual airplanes, involving partial or complete dismantling ("tear-down") of available structure.

e. The effect of major repairs, alterations, and modifications approved by the design approval holder should be considered. In addition, it will be necessary to consider the effect of all major repairs and operator-approved alterations and modifications on individual airplanes. The operator has the responsibility for consideration of any such aspects. For airplanes affected by the Aging Airplane Safety Final Rule, AC 120-93, *Damage Tolerance Inspections for Repairs and Alterations*, provides guidance to type certificate holders and operators for addressing repairs, alterations, and modifications.

2. DAMAGE-TOLERANT STRUCTURES.

a. The damage tolerance assessment of the airplane structure should be based on the best information available. The assessment should include a review of analysis, test data, operational experience, and any special inspections related to the type design. A determination should then be made of the site or sites within each structural part or component considered likely to crack, and the time or number of flights at which this might occur.

b. The growth characteristics of damage and interactive effects on adjacent parts in promoting more rapid or extensive damage should be determined. This study should include those sites that may be subject to the possibility of crack initiation due to fatigue, corrosion, stress corrosion, disbonding, accidental damage, or manufacturing defects in those areas shown to be vulnerable by service experience or design judgment.

c. The minimum size of damage that it is practical to detect and the proposed method of inspection should be determined. This determination should take into account the number of flights required for the crack to grow from detectable to the allowable limit, such that the structure has a residual strength corresponding to the conditions stated under § 25.571.

> **NOTE: In determining the proposed method of inspection, consideration should be given to visual inspection, nondestructive testing, and analysis of data from built-in load and defect monitoring devices.**

d. The continuing assessment of structural integrity may involve more extensive damage than might have been considered in the original fail-safe evaluation of the airplane, such as:

(1) A number of small adjacent cracks, each of which may be less than the typically detectable length, developing suddenly into a long crack;

(2) Failures or partial failures in other locations following an initial failure due to redistribution of loading causing a more rapid spread of fatigue; and

(3) Concurrent failure or partial failure of multiple load path elements (e.g., lugs, planks, or crack arrest features) working at similar stress levels.

3. INFORMATION TO BE INCLUDED IN THE ASSESSMENT.

a. The continuing assessment of structural integrity for the particular airplane type should be based on the principles outlined in paragraph 2 of this appendix. The following information should be included in the assessment. This information should be kept by the manufacturer in a form available for reference:

(1) The current operational statistics of the fleet in terms of hours or flights;

(2) The typical operational mission, or missions assumed in the assessment;

(3) The structural loading conditions from the chosen missions; and

(4) The supporting test evidence and relevant service experience.

b. In addition to the information specified in paragraph 3a of this appendix, the following should be included for each critical part or component:

(1) The basis employed for evaluating the damage tolerance characteristics of the part or component;

(2) The site or sites within the part or component where damage could affect the structural integrity of the airplane;

(3) The recommended inspection methods for the area;

(4) For damage tolerant structures, the maximum damage size at which the residual strength capability can be demonstrated and the critical design loading case for the latter; and

(5) For damage tolerant structures, at each damage site the inspection threshold and the damage growth interval between detectable and critical, including any likely interaction effects from other damage sites.

> **NOTE: If an inspection procedure is not reliable or practicable, then replacement or modification of the structure may need to be defined.**

4. INSPECTION PROGRAM. The purpose of a continuing airworthiness assessment is to adjust the current maintenance inspection program, as required, to assure continued operational safety of the airplane.

a. In accordance with paragraphs 1 and 2 of this appendix, an allowable limit of the size of damage should be determined for each site such that the structure has a residual strength for the load conditions specified in § 25.571, as defined in paragraph 2c of this appendix. The size of damage that it is practical to detect by the proposed method of inspection should be determined, along with the number of flights required for the crack to grow from detectable to the allowable limit.

b. The recommended inspection program should be determined from the data described in paragraph 4a, above, giving due consideration to the following:

(1) Fleet experience, including all of the scheduled maintenance checks;

(2) Confidence in the proposed inspection technique; and

(3) The joint probability of reaching the load levels described above and the final size of damage in those instances where probabilistic methods can be used with acceptable confidence.

c. Inspection thresholds for supplemental inspections should be established. These inspections would be supplemental to the normal inspections, including the detailed internal inspections.

(1) For structure with reported cracking, the threshold for inspection should be determined by analysis of the service data and available test data for each individual case.

(2) For structure with no reported cracking, it may be acceptable, provided sufficient fleet experience is available, to determine the inspection threshold on the basis of analysis of existing fleet data alone. This threshold should be set such as to include the inspection of a sufficient number of high-time airplanes to develop added confidence in the integrity of the structure (see paragraph 1c of this appendix). Thereafter, if no cracks are found, the inspection threshold may be increased progressively by successive inspection intervals until cracks are found. In the latter event, the criteria of paragraph 4c(1) applies.

5. THE SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENT.

a. The supplemental structural inspection document (SSID) should contain the recommendations for the inspection procedures and replacement or modification of parts or components necessary for the continued safe operation of the airplane. The document should be prefaced by the following information:

(1) Identification of the variants of the basic airplane type to which the document relates;

(2) A summary of the operational statistics of the fleet in terms of hours and flights, as well as a description of the typical mission, or missions;

(3) Reference to documents giving any existing inspections or modifications of parts or components;

(4) The types of operations for which the inspection program is considered valid; and

(5) A list of service bulletins (or other service information publication) revised as a result of the structural reassessment undertaken to develop the SSID, including a statement that the operator must account for these service bulletins.

b. The document should contain at least the following information for each critical part or component:

(1) A description of the part or component and any relevant adjacent structure, including means of access to the part;

(2) The type of damage which is being considered (i.e., fatigue, corrosion, accidental damage);

(3) Relevant service experience;

(4) Likely site(s) of damage;

(5) Recommended inspection method and procedure and alternatives;

(6) Minimum-size of damage considered detectable by the method(s) of inspection;

(7) Service bulletins (or other service information publication) revised or issued as a result of in-service findings resulting from implementation of the SSID (added as revision to the initial SSID);

(8) Guidance to the operator on which inspection findings should be reported to the manufacturer;

(9) Recommended initial inspection threshold;

(10) Recommended repeat inspection interval;

(11) Reference to any optional modification or replacement of part or component as terminating action to inspection; and

(12) Information related to any variations found necessary to “safe lives” already declared.

c. The design approval holder should check the SSID from time to time against current service experience. Any unexpected defect occurring should be assessed as part of the continuing assessment of structural integrity to determine the need for revision of the document. Future structural service bulletins should state their effect on the SSID.